

No. 3 — *Types of Fossil Cetaceans in the Museum of Comparative Zoölogy.* BY C. R. EASTMAN.

THERE are preserved in the Museum of Comparative Zoölogy, besides other interesting Cetacean remains, the types and only known representatives of three species of Odontocetes from the middle and late Tertiary formations of this country. Two of these exemplars belong to the Delphinoid, and the other to the Ziphioid division of toothed whales. One of the Delphinoid types has served for the establishment of a distinct genus, *Lophocetus*, whose characters have been insufficiently described, and precise systematic relations are admitted to be uncertain. The original has never been satisfactorily figured, and its companion Delphinoid type, the so-called *Delphinus occiduus* of Leidy, has not been illustrated at all. The present Bulletin is devoted principally to a consideration of these two Delphinoids.

LOPHOCETUS COPE.

Proc. Acad. Nat. Sci. Phil., 1867, p. 146.

First described by Harlan in 1842 under the name of *Delphinus calvertensis*, the species was made by Cope the type of *Lophocetus*, and placed in the vicinity of *Inia* and *Pontoporia* (= *Stenodelphis*). In fact, it was held to be distinguished from the former of these genera only by the "cylindric form of the posterior alveolae, which renders it probable that the teeth were not furnished with lobes as in *Inia*." More than a score of years later, in 1890, the same author speaks with less assurance concerning its relations: "Its position is uncertain; the skull resembles that of *Inia*, but the roots of the teeth are cylindric. The temporal and occipital ridges are very strong. Skeleton unknown."¹

Save for one or two exceptions, subsequent writers have accepted Cope's general determination. Dr. Theodore Gill, in 1872, recognized *Inia* and *Platanista* as types of independent families, and provisionally placed *Lophocetus* among fossil Iniidae.² The more usual practice has been to assign subfamily values to the groups represented by the two modern genera, and include them under Flower's comprehensive designation of *Platanistids*. Dr. O. P. Hay accordingly refers *Lophocetus*, though with some reservation, to the subfamily *Platanistinae*.³ On the other hand Dr. E. C. Case states positively that its position is with the *Iniinae*

¹ The Cetacea. Amer. Nat., 1890, 24, p. 606.

² Arrangement of the families of Mammals. Smithson. Misc. Coll., No. 247.

³ Fossil Vertebrata of North America. Bull. 179, U. S. Geol. Surv., 1902, p. 590.

among "forms with cylindrically rooted teeth."¹ The only author who has argued against an association with Platanistids, as commonly understood, is Prof. J. F. Brandt, who concluded from the general aspect of the skull and form of the teeth that it approached very closely the existing Whitefish, *Delphinapterus leucas*. He even questioned the propriety of regarding it as the type of a distinct genus: "Der Schädel ähnelt offenbar dem von *Delphinapterus leucas*. Als Typus einer eigenen Gattung möchte ich sie daher, wenigstens vorläufig, noch nicht gelten lassen."² Within recent years Dr. Othenio Abel has reiterated the same opinion.³ Thus the matter stands at the present time.

It may be well to present here Cope's original definition of the genus, to which nothing has since been added. This is given as follows:

LOPHOCETUS COPE.

"Temporal fossa truncated by a horizontal crest above, prolonged backwards and bounded by a projecting crest, which renders the occipital plane concave. The same crest prolonged upwards and thickened, each not meeting that of the opposite side, but continued on the inner margins of the maxillary bones, turning outwards and ceasing opposite the nares. Front, therefore, deeply grooved. Premaxillaries separated by a deep groove. Teeth with cylindric roots."

Lophocetus calvertensis (HARLAN).

1842. *Delphinus calvertensis* Harlan, Bull. of Proc. Nat. Inst., p. 195, Plates, 1-3.
 1842. *Delphinus calvertensis* Dekay, Nat. Hist. N.Y. Zool. pt. 1, p. 136.
 1842. *Delphinus calvertensis* Markoe, L'Institut, 10, p. 384.
 1866. *Pontoporia calvertensis* Cope, Proc. Acad. Nat. Sci. Phil., p. 297.
 1867. *Lophocetus calvertensis* Cope, Proc. Acad. Nat. Sci. Phil., p. 144, 146.
 1869. *Lophocetus calvertensis* Leidy, Journ. Acad. Nat. Sci. Phil., (2) 7, p. 435.
 1873. *Lophocetus calvertensis* Brandt, Mém. Acad. Imp. Sci. St. Petersb., (7) 20, p. 288.
 1880. *Lophocetus calvertensis* Van Beneden and Gervais, Ostéographie des Cétacés, p. 512.
 1890. *Lophocetus calvertensis* Cope, Amer. Nat., 24, p. 606, 615.
 1896. *Lophocetus calvertensis* Roger, Verzeichniss fossiler Säugethiere, p. 79.
 1899. *Lophocetus calvertensis* Abel, Denkschr. k.k. Akad. Wissensch., 68, p. 869, 873.
 1902. *Lophocetus calvertensis* Hay, Bull. 179, U. S. Geol. Surv., p. 590.
 1904. *Lophocetus calvertensis* Case, Maryland Geol. Surv. Miocene, 26, p. 9, Plates 16, Fig. 1.

The type specimen consists of a well-preserved skull, from which the lower jaw and forward extremity of the muzzle are wanting. There are preserved besides all of

¹ Maryland Geological Survey, Miocene, 1904, p. 9.

² Die fossilen und subfossilen Cetaceen Europa's. Mém. Acad. Imp. Sci. St. Petersb., (7) 1873, 20, p. 288.

³ Fossile Platanistiden des Wiener Beckens. Denkschr. k.k. Akad. Wissensch., 1900, 68, p. 869.

the cervical vertebrae. The latter, with the exception of the atlas, which remains adherent to the occiput, are not mentioned in the original description nor in any subsequent notice of the specimen. On the other hand, the principal features of the skull are well signalized by both Harlan and Cope, from the former of whom we quote as follows:—

“This interesting fossil consists of the skull, nearly complete, densely petrified, very weighty, tinged of a deep black, ferruginous color; characteristic marine fossil shells adhere to its base. . . . The external border of the superior maxillary bones is slightly broken on each side. Its discovery is due to the active researches of Mr. Francis Markoe, Jr., Corresponding Secretary of the National Institution, who obtained it from the Calvert cliffs, on the right bank of the Chesapeake bay, State of Maryland, along with other characteristic fossils. . . .

“The present specimen belongs to Cuvier’s first subgenus, or “*les Dauphins à long bec*” [= type of *Champsodelphis* Gervais]. On comparison with the numerous species of living dolphins, it is found distinct from all of them. It approximates the *Delphinapterus leucorampus*, of Peron,¹ but differs in its various measurements, number of teeth, and in the arrangement of the palatine bones. . . .

“*Description of D. Calvertensis.*—In general outline, resembling other skulls of this genus. The head is proportionally narrower, and snout more elongated, than the Italian specimen with which I have compared it. The occipital and temporal ridges are strongly developed, indicating muscular strength, especially of the jaws. We find similar indications in the remains of the teeth, which have been large and robust. There are ten sockets remaining on the right side, with the teeth broken off at the rim. These organs approximate each other. The ten sockets include a line four and a half inches long. There has been about one and a half inches of the end of the snout broken off, which would afford room for two or three more teeth, making twelve or thirteen in all, on each side. The pyramidal eminence anterior to the posterior nares, on the palatine surface, is strongly pronounced. It terminates opposite the last tooth. The excavations or longitudinal grooves, on each side of the upper portion of this eminence, are unusually deep. The palatine surface is slightly convex transversely. Above, the head is narrower across the occipital ridges than other allied species, and narrower than the transverse diameter of the base of the skull. The *ossa nasi* are longer than broad, and convex. The atlas vertebra adheres to the occiput, above the condyles. It measures, across the transverse processes, five inches; transverse diameter, three inches; and the ring is about one inch thick.”—(p. 196).

In connection with the above description, the following measurements are given, to which we have added their metrical equivalents in parentheses. The author states in regard to the missing portion of the rostrum that “one and a half inches must be considered as the length of the last portion of the extremity of the snout.”

Dimensions:

Total length of head, from the temporal crest to the presumed
extremity of the jaw 17 in. (432 mm.)

¹ *Vide* Cuvier, *Ossemens Fossiles*, 5, pt. 1, p. 289, Plate 21, Figs. 5 and 6, ed. 1823.

From the anterior border of the spiracles to the presumed ex-	
tremity of snout	11.5 in. (292 mm.)
Breadth of skull above, across the occipital crests	5.0 in. (127 mm.)
Breadth at base, between the temporal bones	6.5 in. (165 mm.)
Longest diameter of largest tooth at the socket	0.35 in. (8.9 mm.)

Besides the foregoing, we may point out the following important characters whose combined weight is considered sufficient to establish beyond doubt the Platanistid relations of the form in question. (1) The cervical vertebrae are all free, and each one is of considerable length for a Cetacean; (2) the general form of the skull resembles that of *Inia* and *Pontoporia* (= *Stenodelphis*), but is relatively narrower behind, and has steeper lateral and posterior walls; (3) the large and nearly vertical parietals are widely separated from each other by the upward crowding of the supraoccipital, which is also wedged in between the frontals at the summit: in this region the frontals are visible only as narrow bands, continuous with the tumid nasals in front, enclosing the interparietal between them, and being themselves almost entirely concealed behind by the overroofing laminae of the maxillary elements; (4) the temporal fossa is large, and would appear to have been open in front; that part of the squamosal supporting the zygomatic process is very massive, and the orbital portion of the maxillary and frontal is correspondingly thickened; (5) the pterygoids are displaced from contact with each other in the median line through intervention of the vomer, and do not enclose an involted air-space open behind; they entirely surround the palatines as in *Inia* and *Pontoporia*, and may have had (though this cannot be determined definitely from the present condition of the specimen) an articulation with the squamosal behind; the basal portion of the rostrum is wide and transversely arched; and (6), the premaxillaries, of extremely dense structure, are separated by a deep longitudinal cleft, and are broadly expanded without being inflated on either side of the narial orifices.

From the review already given it appears that, with the exception of Brandt and Abel, authors are agreed in including *Lophocetus* among Platanistids, but hold different opinions concerning which of the two subfamilies, Platanistinae or Iniinae, it is more nearly related. With Cope, we are persuaded that there is much greater structural resemblance to *Inia* and *Pontoporia* than to *Platanista*, among recent forms. The highly characteristic maxillary crests of the susu are not present in *Lophocetus*, the pterygoids do not unite in the median line to form an arch which almost entirely conceals the palatines, the latter do not extend in advance of the pterygoids along the basal portions of the rostrum, and the supraoccipital joins the parietals along crests that rise vertically and then flare slightly outwards, instead of being concave inwardly, as in the susu. On the other hand, as compared with *Inia*, only unimportant differences are found. The walls of the brain cavity are less rotund, the crests, as connoted by the generic name, are more powerfully developed, the nasals are crowded backwards so as to override the frontals at the vertex, which latter is divided by a deep longitudinal cleft, and the premaxillaries are more widely separated. The occipital condyles are rela-

tively broader in the fossil form than in *Inia*, but otherwise the bones forming the basicranial axis are remarkably similar. It is to be regretted that injury to the specimen prevents comparison of the bones in the orbital region, the zygomatic arch, and characters of the dentition. One can merely affirm that the teeth were single-rooted, and probably of cylindrical form, that is, without the additional tubercle shown by the posteriorly situated teeth in *Inia*. In so far as these latter may be said to recall something of the primitive condition of molars, whereas *Lophocetus* is homodont, the dentition of the Miocene genus is more specialized. But here we must not lose sight of the fact that *Lophocetus* is adapted to a marine, and *Inia* to a fluviatile habitat. The utility of a homodont-polyodont dentition to marine Carnivores, and the successive stages by which this condition is attained among Cetaceans, have been clearly demonstrated by Dames and others.¹

In seeking for the nearest fossil allies of *Lophocetus*, attention is naturally directed first toward those forms which are regarded as standing in the immediate vicinity of *Inia*, possibly even in ancestral relations to the modern genus. Now a number of Tertiary forms are known whose characters accord in the main with those of *Inia*, and hence are properly included within the same subfamily. It may be doubted whether any of them fulfil the requisites of a direct ancestor of existing Iniinae, since they combine in their organization both generalized Cetacean characters, and also some others that indicate the animals were too specialized to be the progenitors of *Inia*. Among these Tertiary forms that present close structural resemblances to the modern type may be mentioned *Iniopsis*, from the Caucasian Eocene, the skull of which is incompletely known; several Platanistid species which are grouped by Abel under the new generic titles "*Acrodelphis*" and "*Cyrtodelphis*," from the European Miocene; and also the South American form described by Mr. Lydekker as *Argyroctetus patagonicus*. We should expect to find no less intimate resemblances between these forms and *Lophocetus*, on bringing them together.

Before undertaking comparisons, however, a word or two is necessary to explain the status and synonymy of the new names employed by Abel to designate practically the same grouping of species as was formerly included under Gervais's titles *Champsodelphis* and *Schizodelphis*. Both of these generic titles were suppressed by the Viennese author² in his memoir of 1899, and the names *Aerodelphis* and *Cyrtodelphis* substituted for them on the basis of newly

¹ Dames, W., Ueber Zeuglodon aus Aegypten. Pal. Abhandl., 1894, 5, p. 212. — Fraas, E., Neue Zeuglodonten aus dem unteren Mitteleocän vom Mokattam bei Cairo. Geol. und Palaeont. Abhandl., n. s., 1904, 6, p. 199-220. See also, concerning origin of polyodont dentition among Squalodonts, Kükenthal, W., Vergleichend-anatomische und entwickelungsgeschichtliche Untersuchungen an Walthieren. Denkschr. Med.-Nat. Gesellsch. Jena, 1893, 3, p. 421. — Weber, M., Studien über Säugethiere. Jena, 1886, pt. 1, p. 194-195.

² Abel, O., Untersuchungen über die fossilen Platanistiden des Wiener Beckens. Denkschr. k.k. Akad. Wissensch., 1900, 68, p. 840.

defined differential characters, but without sensibly altering their respective contents. Thus, the type species belonging to the two older genera became in each case the typical species of the newly proposed genera. In other words, a valid generic distinction was recognized between two groups of fossil species for each of which a definite type was selected; and in each case the definite type so selected was identical with the type of a previously described genus. By this process of emendation and redefinition, the integrity of the older generic terms was not, and, according to ordinary rules of nomenclature, could not have been impaired. The genus *Champsodelphis* Gervais, typified by *C. macrogenius* (Laurill.) (= *C. macrognathus* Brandt), and represented by a number of other species as well, might be restricted, enlarged or otherwise modified, even broken up into several genera; but in the latter case the name *Champsodelphis* must be retained to designate that section which contains the original type of the genus. Similarly, in the case of *Schizodelphis*, so long as the typical species *S. sulcatus* Gervais is not proved to belong to any previously described genus, the original generic title must be retained, and no new one can be substituted in place of it. Therefore it becomes necessary to regard Abel's proposed title of *Cyrtodelphis*, having *S. sulcatus* Gervais for its type, as a synonym pure and simple of the older *Schizodelphis*, which has the same type species. In the case of *Champsodelphis*, Abel has himself rectified his error of 1899 by restoring this name to good and regular standing. He restricts it in his Brussels memoir of 1905 so as to include only the type species, and employs the name *Acrodelphis*¹ as a collective designation for the nine or ten other species formerly embraced under *Champsodelphis*.

Some confusion exists as to exactly what constitutes the type species of *Champsodelphis*. Trouessart, in the quinquennial supplement, 1905, to his "Catalogus Mammalium," correctly indicates *C. macrogenius* (Laurill.) as the type. Abel, in his memoir published the same year, gives it as *C. macrognathus* Brandt. Both names refer to precisely the same thing. The extent of Brandt's changes was merely to restrict the application of Laurillard's title to the original of Cuvier's "Dauphin à longue symphyse de la mâchoire inférieure, déterré dans une sablière du département des Landes," and to found a new species, *C. valenciennesi*, upon a second specimen that Laurillard (and following him, Gervais) had associated with the type. Subsequently it was pointed out by Abel that the so-called *C. valenciennesi* of Brandt bore sufficient resemblance to *Tursiops* as to warrant its exclusion from *Platanistids* altogether. But instead of retaining Laurillard's well-founded specific name for Cuvier's original, he

¹ As pointed out by M. Trouessart (*Revue Critique de Paléozoologie*, 1906, 10, p. 205), the genotype of *Acrodelphis* is *A. letochae* (Brandt). "Contrairement aux usages," continues this author, "M. Abel donne comme 'types' de ce genre trois espèces (*A. Letochae*, *A. Omboni*, *A. denticulatus*). Il veut dire, sans doute, que ces trois espèces sont typiques." A discussion of methods of fixing the types of genera was introduced by Witmer Stone, in *Science*, 1906, 24, p. 560, and continued by various other systematists.

adopts Brandt's altered designation of *C. macrognathus*.¹ This procedure is entirely arbitrary, and contrary to recognized principles of nomenclature. There is no other course than to regard *C. macrognathus* Brandt as a synonym of *C. macrogenius* Laurillard, and it is in this sense that the former name should be understood in those places where it occurs in the following passage. This quotation from Abel is made in order to allow readers the opportunity of judging for themselves whether we have correctly represented his position:—

“La grande incertitude qui régnait à l'égard du genre *Champsodelphis*, Gerv., m'a conduit, en donnant une liste des espèces de *Schizodelphis*, Gerv., et de *Champsodelphis*, Gerv., à renoncer à ces deux noms et à leur substituer deux autres genres, *Cyrtodelphis* et *Acrodelphis*. J'ai mis dans le genre *Acrodelphis* l'original du 'Dauphin à longue symphyse de la mâchoire inférieure, détérré dans une sablière du département des Landes,' de Cuvier, qui avait été décrit par Brandt sous le nom de *Champsodelphis macrognathus*; j'ai encore joint à ce genre les espèces suivantes: *Acrodelphis lophogenius*, Valenc., *Acrodelphis Ombonii*, Longhi, *Acrodelphis Letochae*, Brandt, et *Acrodelphis Krauletzki*, Abel. . . .

“Mais des études prolongées sur les Odontocètes des dépôts tertiaires de l'Europe me font voir que le groupement proposé par moi, en 1899, n'est plus satisfaisant. J'ai eu l'occasion de comparer en détail les restes des espèces d'*Acrodelphis* du bassin de Vienne avec les types belges et les restes des formations miocènes du Nord de l'Allemagne, et je suis, maintenant, d'avis que la diagnose du genre *Acrodelphis* donnée en 1899 doit être plus restreinte qu'elle ne l'a été alors.

“Comme la mâchoire inférieure du *Champsodelphis macrognathus*, Brandt, se distingue absolument par sa taille et ses dents très espacées d'*Acrodelphis Letochae*, Brandt, et l'*Acrodelphis Ombonii*, Longhi; qu'en outre, la forme de la couronne est très différent dans les deux types; je suis d'avis que l'*Acrodelphis macrognathus*, Brandt, doit être considéré comme le représentant d'un genre différent d'*Acrodelphis*. Puisque le nom générique de *Champsodelphis* a été établi par Gervais pour la mâchoire inférieure des Landes qui a d'abord été décrit par Cuvier, mais que cette mâchoire inférieure est absolument différente des espèces décrites plus tard sous le même nom générique: *Champsodelphis (Acrodelphis) Letochae* et *Champsodelphis (Acrodelphis) Ombonii*, on doit conserver le nom de Gervais pour *Champsodelphis macrognathus*, tandis que le nom d'*Acrodelphis* doit rester pour les types beaucoup plus petits, armés de dents beaucoup plus serrées. . . .

[Les types de ces deux genres seraient:]

“1. *Champsodelphis*, Gervais. Type: *Champsodelphis macrognathus*, Brandt.

“2. *Acrodelphis*, Abel. Types: *Acrodelphis Letochae*, Brandt; *Acrodelphis Ombonii*, Longhi; *Acrodelphis denticulatus*, Probst.”

Before passing from this subject of nomenclature, it will be instructive to glance at Abel's proposed grouping of Platanistids in general, as set forth in his recent

¹ The reasons proffered by Brandt in justification of this course are thus stated by him: “Ich schlage statt des Namens *macrogenius*, der ohnehin keinen rechten Sinn hat, den bezeichnenderen *macrognathus* vor, weil unter *D. macrogenius* Laurillard zwei Arten stecken, wie Valenciennes nachwies.”

memoir. Most authors employ the term *Platanistidae* to include the two modern subfamilies of *Platanistinae* and *Iniinae*, together with the known fossil allies of either. The arrangement proposed by Dr. Theodore Gill in 1872 differs from the one commonly in vogue only in that the minor subdivisions are elevated to the rank of independent families. At that time the *Iniidae* alone were known to have fossil representatives, and even now opinion is divided as to which of the two groups some of the fossil forms should be referred. Abel's scheme is practically a revival of Gill's arrangement. In his latest memoir (1905) the family *Platanistidae* is restricted to the genus *Platanista* itself. The *Iniidae* of Gill are renamed *Acrodelphidae*, and made to comprise four subfamilies, one of which includes *Delphinapterus* and *Monodon*. In addition, two other independent families are recognized, one being typified by *Eurhinodelphis*, the other by *Saurodelphis*. All of these family divisions are considered to have equal rank with the *Physeteridae*, *Ziphiidae*, and *Delphinidae*, and to trace their origin back to *Squalodon*, but not to *Zeuglodon*, which is regarded as much too highly specialized to have been the direct ancestor of *Squalodontidae*. It is suggested that the latter were probably descended from small terrestrial Carnivores, and the *Delphinidae* from still another group, the *Odontocetes* being thus of diphyletic origin. Such, in brief, are Abel's more general conclusions.

In order to point out more clearly the exact equivalence between the so-called *Acrodelphidae* of Abel, and the earlier defined *Iniidae* of Gill, we may be permitted to reproduce the following summary given by the first-named author at page 129 of his memoir on *Odontocetes* : —

“Résumé général : Par les caractères de sa dentition et de son crâne, *Cyrtodelphis* se montre étroitement allié à *Argyroctetus*, *Inia*, *Pontistes* et *Pontoporia*, comme avec *Acrodelphis*, et doit donc former un même groupe avec ces formes. Ce groupe correspondrait partiellement aux *Platanistides*, dans les limites que Zittel a données à cette famille ; mais, comme *Platanista* doit être éliminé, il faut choisir un autre nom. Puisque *Acrodelphis* est le type fossile le plus primitif de ce groupe, on devra se servir du nom de famille *Acrodelphidae*. Nous aurons alors à distinguer :

“ACRODELPHIDAE.

- “1. Sous-famille. *Argyroctetinae* : *Argyroctetus*, *Cyrtodelphis*, *Pontivaga*, *Ischyorhynchus*, *Champsodelphis*. [s. str.]
- “2. ” *Acrodelphinae* : *Acrodelphis*, *Heterodelphis*
- “3. ” *Iniinae* : *Inia*, *Pontistes*, *Pontoporia*.
- “4. ” *Beluginae* : *Beluga*, *Monodon*.”

With regard to the last subfamily, which should properly be called *Delphinapterinae*, the author makes the following observations : “*Beluga* et *Monodon* montrent de grandes ressemblances avec les *Acrodelphides*, tandis qu'ils diffèrent des *Delphinides*. J'ai, à cause de cela, considéré ces deux genres comme une sous-famille des *Acrodelphides* ; leur origine n'est pas encore éclaircie. Les vertèbres cervicales libres prouvent qu'ils ne descendent pas des *Delphinides*.”

We may now return to the principal matter at issue, namely, a comparison between *Lophocetus* and certain fossil genera which are regarded as standing in close relations with *Inia*, and are commonly assigned to the same subfamily. Now, the greater number of fossil Platanistids, or Iniidae in Gill's sense of the term, are remarkable for having the rostrum greatly elongated. In recognition of this fact, Abel divides his so-called Acrodelphidae into two sections, the first three subfamilies listed above being embraced in a section of 'Longirostres,' and the fourth, containing only *Delphinapterus* and *Monodon*, constituting the 'Brevirostres.' At first sight these longirostrate Platanistids would seem to present a marked difference from *Lophocetus*, for, as noted by Harlan, it does not appear that the rostrum in this form was greatly produced, and probably not more than a few inches are missing from it in its present condition. The solidity of the parts composing the muzzle, and general resemblance of the latter to that in brevirostrate Delphinoids, are in harmony with Harlan's conclusion, and so also are the facts of geographical distribution. Longirostrate Platanistids are especially characteristic of European Tertiary deposits, whereas on this side of the Atlantic forms like *Champsodelphis*,¹ *Schizodelphis*, *Eurhinodelphis*, etc., are conspicuously absent, being replaced, apparently, by brevirostrate genera. Probably the explanation of this fact is to be found in differences of physical conditions, such as are to be inferred from the different constitution of the faunas as a whole, and from the different nature of the sediments composing the deposits.

The Miocene deposits of the Middle Atlantic Slope in this country are of characteristically marine type, as indicated by both structural and fossiliferous evidence. On the other hand the corresponding Old World formations from which Delphinoid remains have been obtained are on the whole less clearly of marine origin, and the very circumstance that most of these Delphinoids are longirostrate has been interpreted in the light of adaptation to estuarine or even fluviatile conditions. For as shown by Dollo² and various other writers, it is precisely this modification that is oftenest met with in widely diverse orders of vertebrates where forms have become adapted to a littoral or fluviatile existence, as for instance, *Lepidosteus* among fishes, and *Champsosaurus*, *Phytosaurs*, and modern and extinct gavials among reptiles. Dr. J. H. McGregor,³ in his memoir on the *Phytosauria*, calls attention to the striking resemblance of the rostrum to the snout of *Lepidosteus*, and quotes Fraas's observation that its decurved tip "perhaps demonstrates a habit of rooting in mud for food, and catching fishes." Cope,⁴ also, noted a somewhat analogous formation of the rostral portion of the jaw in *Anoplouassa*, and offered a similar explanation. And more recently, the same conclusion has been put forward by Abel⁵ in following language:—

¹ The reference to this genus of certain detached teeth and vertebrae from the Maryland Miocene must be regarded as provisional only.

² Nouvelle note sur le *Champsosaure*, Bull. Soc. Belge Géol., 1891, 5, p. 153.

³ *Memoirs Amer. Mus. Nat. Hist.*, 1906, 9, p. 38.

⁴ *Proc. Amer. Philos. Soc.*, 1869, 11, p. 189.

⁵ *Mem. Mus. Roy. d'Hist. Nat. Belg.*, 1905, 3, p. 154.

“Des museaux excessivement longs, tels que nous les trouvons chez Eurhinodelphis, Cyrtodelphis, Acrodelphis, Inia, Pontoporia et Platanista, paraissent être particuliers aux animaux fluviaux, ou plus précisément, à ceux qui se servent de l'extrémité du museau pour fouiller la vase et en faire sortir la nourriture minuscule qui y grouille tout comme chez les oiseaux à long bec (herons, cigognes, bécasses, etc.), oiseaux de marais et de rivages, dont le bec est, physiologiquement, non morphologiquement, identique aux longs rostres des dauphins fluviaux. Le bec d'une bécasse est entièrement analogue au rostre de Pontoporia.”

Enough has now been said by way of emphasizing the purely adaptive feature presented by the elongated rostrum of most Miocene Iniinae (Iniidae of Gill). Therefore, notwithstanding the marked difference in this respect which is exhibited by *Lophocetus*, we may still place all these forms in close association with the typical existing genus on account of mutual resemblances in other respects. It is unnecessary to enumerate here the various points of agreement that have been observed between *Inia* and leading longirostrate forms like *Champsodelphis* and *Schizodelphis*; for particulars one may refer to Abel's memoir of 1899, already several times quoted. These two genera, according to this author (p. 868), are very intimately related to *Inia*, but on the other hand *Saurodelphis* and *Eurhinodelphis* are more distantly related, and belong probably to a different evolutionary series. Accepting this conclusion, it is interesting to note that *Lophocetus* displays rather close resemblances to the two first-named genera, and also to *Acrodelphis* in the restricted sense that the term is now understood by its author. Yet there is even closer affinity between *Lophocetus* and *Inia* itself. *Schizodelphis* and *Eurhinodelphis* are to be regarded as more primitive than the form we are considering, and more primitive also than modern Iniinae, in that the frontals take part to a considerable extent in forming the gently rounded summit of the cranium, where they are freely exposed, and are either wholly or partly separated from each other by the interparietal. But in *Lophocetus* the interparietal, which is fused with the steeply inclined supraoccipital, barely excludes the frontals from meeting in the middle line at the vertex of the cranium. Needless to say, too, that the disposition of the parietals in *Lophocetus* differs radically from that observed in *Saurodelphis*, where they retain more nearly their primitive arrangement and are in contact with each other in the median line. But as compared with *Schizodelphis*, the large extent of the parietal surface, the high vertical walls formed by these bones, and their powerful crests for the attachment of jaw muscles, show considerable likeness, and it is only in the more primitive arrangement of the frontals that this portion of the cranium differs very conspicuously in the two genera.

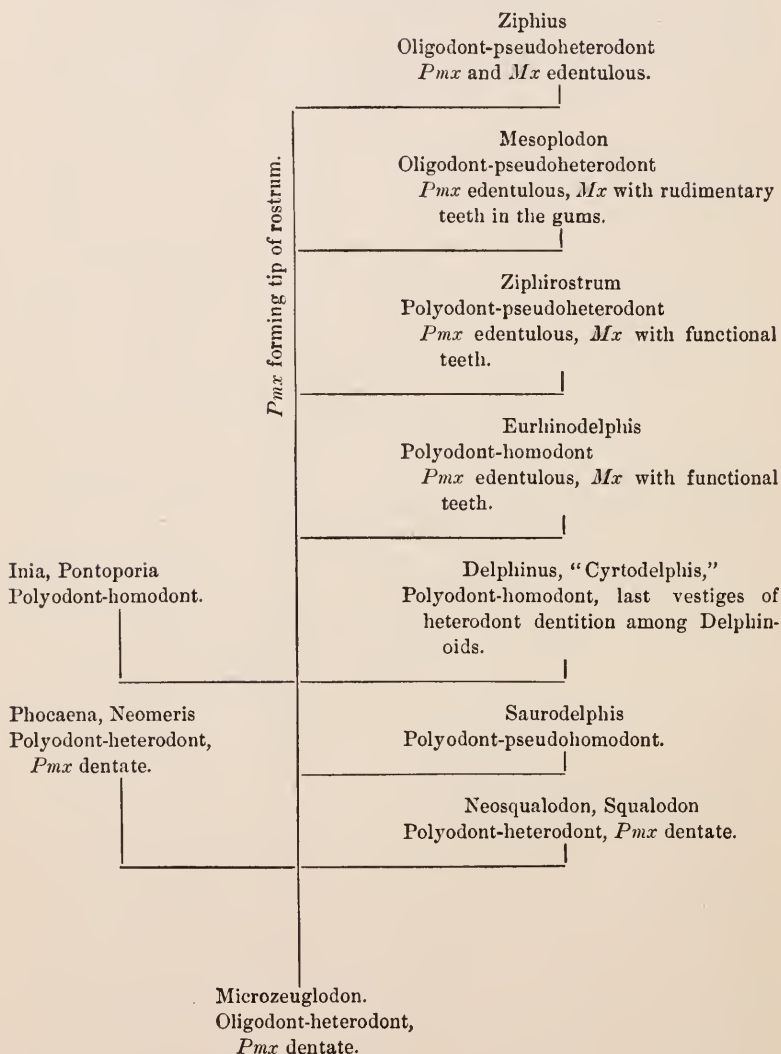
Neither *Lophocetus* nor any of the best known longirostrate genera resemble *Eurhinodelphis* in having such highly specialized characters as a completely closed temporal fossa and greatly thickened supraorbital ridges. Closed temporal fossae are the rule among Dolphins proper, Ziphioids, and the Physteridae, but occur only exceptionally among fossil Platanistids. Like *Eurhinodelphis*, however, but unlike *Inia* and *Iniopsis*, there is no swelling or thickening of the pre-

maxillaries on either side of the narial openings, but these bones are flattened here, and rather widely expanded. *Lophocetus* shows the same squarish excavation of the maxillaries on either side of the vertex that occurs in modern Iniinae, and also in *Pontistes* and *Iniopsis*, but in none of these do the maxillary fossae have such prominent borders. A peculiar feature of *Lophocetus*, as compared with both recent and fossil Iniinae, is that the prominence formed by the nasals and frontals immediately behind the narial apertures is deeply cleft in a longitudinal direction. Moreover, in *Inia* this eminence is formed almost entirely by the frontals, which enlose the interparietal between their upturned borders posteriorly, and completely cover the nasals at the vertex in front. But in *Lophocetus* the frontals scarcely appear in this region, and the divided, nodulose nasals are conspicuously developed, alone forming with the mesethmoid the posterior wall of the external nares. This wall is relatively broader and less convex in a transverse direction than in *Inia*, but by no means presents the well-defined quadrate surface that is so strongly marked a feature of *Iniopsis*. The characters of the basicranial axis, and especially the arrangement of palatine and pterygoid elements, point to a closer relationship with *Inia* than with any known fossil form.

It is to be regretted that, owing to the imperfect condition of the specimen, comparisons cannot be made between *Lophocetus* and other Iniinae with respect to the dentition and extremity of the snout. One is perhaps permitted to infer from the general agreement in other respects that the dentition had become polyodont-homodont, and that teeth were still borne by the extremity of the premaxillary. The deep fissure separating these last-named bones in advance of the mesethmoid is probably without greater significance than the fused condition of the interparietal, both of which are regarded as old-age characteristics. On the whole, considerable reason is found for supposing *Lophocetus* to belong to the ancestral line from which modern Iniinae are directly descended. *Saurodelphis*, on the basis of its dentition, would be regarded as more primitive than any of these forms, and *Eurhinodelphis*, with its edentulous premaxillary resembling that of Ziphioids, would be considered more highly specialized. Further material is necessary, however, before one can speak confidently in regard to the direct line of succession. We may conclude this part of the discussion by reproducing the scheme devised by Abel¹ for showing at a glance his views of phylogenetic and other relations.

¹ *Mém. Musée Roy. d'Hist. Nat. Belg.* 1901, 1: 39.

PHYLOGENY OF ODONTOCETES.



We have substituted the genus *Microzeuglodon*, instead of *Zeuglodon*, as the initial member of the above series, in accordance with the author's most recent suggestion, published since the table first appeared. The opinion of most modern writers regarding the impossibility of viewing *Zeuglodon* as the ancestor of *Squalodonts* is accepted by Abel, who announces further the following general conclusions:—

1. The genus *Squalodon* is not descended from *Zeuglodon*.
2. The precursor of *Squalodonts* is to be sought for among small *Archaeoceti*, probably in *Microzeuglodon*.
3. The most primitive *Squalodont* known at present is *Neosqualodon*.
4. *Microsqualodon* represents a lateral offshoot of *Squalodonts*, transitional between the genera *Acrodelphis* and *Delphinodon* (which may be identical).
5. Under *Squalodontidae* are comprised very heterogeneous types, which should be clearly distinguished from one another.

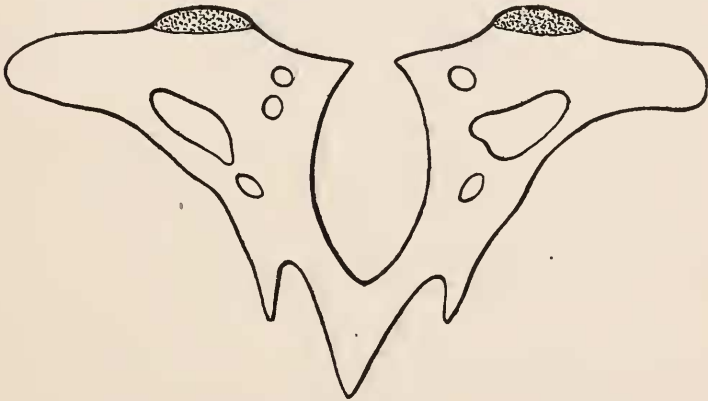


FIGURE A.

Transverse section across basal portion of rostrum of *Lophocetus* as provided by accidental fracture-line seen in Plate 1. $\times \frac{1}{2}$.

The more general features of the skull of *Lophocetus* have now been considered, and the relations they are presumed to indicate have been pointed out. A brief reference may be made here to the illustrations of the type specimen, before passing on to consider the series of cervical vertebrae preserved with the skull.

Plates 1 and 2 show respectively the dorsal and inferior aspects of the cranium, photographed from the actual specimen, and reduced to one-half the natural size. The two transverse fracture-lines appearing in the specimen, one slightly in advance of the position of the antorbital notch (the prominence for which is not preserved), and the other which forms the present termination of the muzzle, have been utilized for preparing the cross-sections shown in Figures A and B. In these will be noted the wide separation of the premaxillaries, these elements

being stippled in the drawing; the large sinus occupied by the mesethmoid cartilage; and the ample size of the longitudinal vascular canals. In the more posterior cross section (Fig. *A*), none of the sutures are distinctly marked, hence the relations of mesethmoid, pterygoids, and maxillaries at the base of the figure are best understood through comparison with the photograph of these parts given in Plate 2. In the same plate will be noticed the extremely well preserved periotic elements, which have fortunately been retained in place, notwithstanding the loss of the tympanic bullae. The periotics are more elongate than the corresponding elements in *Inia*, with more bulbous promontory, and more strongly developed processes for attachment with the bullae. It is noteworthy that in both elements the stapes still remains seated in its proper orifice. The opening seen on the inner side of the periotics in Plate 2, and also of the natural size in



FIGURE B.

Transverse section of rostrum in the type of *Lophocetus* taken at line of fracture along which the forward extremity is severed off. $\times \frac{1}{2}$.

Plate 4, Fig. 2, where a foramen normally occurs, leads directly into the cranial cavity; this is empty, and its walls may be viewed from behind through the foramen magnum.

The occipital border of the skull is indistinctly shown in both plates by reason of the fact that the atlas, within which is included also a portion of the axis, remains firmly cemented to the skull by matrix. It has been allowed to remain in this condition, as have also several characteristic shells (*Turritella*), to serve for purpose of identification with the original of Harlan's figures, and to leave no possible doubt that the series of cervical vertebrae about to be described belong to the same specimen. No mention of these latter has been made in any previous description. They are proved, however, to belong to the type specimen, by the fact that the axis has been fractured in such manner as to leave a portion of the centrum within the ring of the atlas, against which the remaining portion fits perfectly. The block of matrix in which the vertebrae are embedded without disturbing their natural position is shown in Plate 3.

Cervical Vertebrae. — The entire series of cervicals is preserved, together with portions of the first three dorsals, all in natural association. Their features may be best described by saying that they reproduce in strikingly similar manner those of the corresponding structures in *Inia*, the resemblance being much closer than with any other genus. This similitude is found in the form of the individual vertebrae, their relative size, and arrangement with respect to each other, especially as regards the undulating overlap of the neural arches. Saving only that the atlas is more transversely elongate in *Lophocetus* than in the modern genus, it might be referred with equal propriety to either, if found in the detached condition. In both forms, the suboval ring of the atlas is of considerable thickness, with feeble neural spines and abbreviate transverse processes, the latter pointed slightly upward and outward, and provided below with a large flattened hypapophysial process for articulation with the axis, which has, of course, no distinct odontoid process. Owing to abrasion of the neural arch in the axis and third cervical vertebra, their spinous processes, such as they were, have been entirely destroyed; and the same is true for the last cervical and first three dorsals. All of the intervening cervicals, however, retain traces of very feebly developed neural spines.

On the under side of the series are seen in cross-section the stumps of the downwardly directed transverse processes, now broken off, belonging to the fifth and sixth cervicals. Their relations are apparently identical with those in *Inia*. On the inferior side, also, the size of the different centra is displayed to best advantage. Measurements taken here of these bodies are given as follows:—

Length of 1st cervical vertebra	3.0 cm. (approximately)
“ 2d “ “	2.0 “ “
“ 3d “ “	0.6 “ “
“ 4th “ “	0.8 “ “
“ 5th “ “	0.7 “ “
“ 6th “ “	0.8 “ “
“ 7th “ “	1.3 “ “
“ 1st dorsal “	1.8 “ “
“ 2d “ “	2.3 “ “
Height of atlas	8.2 “ “
“ axis	6.2 “ “
“ 7th cervical vertebra	6.4 “ “
Width of atlas including processes	12.4 “ “
“ axis “ “	10.0 “ “

Delphinus occiduus LEIDY.

Plate 4, Fig. 1.

The second type specimen to be considered, although referred by Leidy, who first described it, unqualifiedly to the genus *Delphinus*, is to be understood rather as belonging to the group of *Dolphins* proper, that is, to the subfamily *Delphininae*, than as embraced within the more circumscribed limits of the typical genus. This

limitation is a necessary consequence of the fact that our only knowledge of the form is derived from a fragmentary portion of the rostrum, shown of the natural size in Plate 4, Fig. 1. The original belongs to the J. D. Whitney Collection, presented to the Museum in 1895. It would be superfluous to add anything to Leidy's excellent description (Proc. Acad. Nat. Sci. Phil., 1868, p. 197), which is reproduced in the following paragraph:—

“*Delphinus occiduus*. — An extinct species is indicated by a fossil derived from the upper miocene formation of Half-moon Bay, California, submitted to my examination by Prof. J. D. Whitney. The specimen consists of an intermediate portion of the upper jaw, devoid of teeth, and encrusted with selenite. It measures along the more perfect lateral border 5 inches, and in this extent is occupied with 19 closely set, circular alveoli, rather over two lines in diameter. At the back of the fragment the jaw has measured a little more than 2 inches wide. From this position it gradually tapers for half its length, and then proceeds with parallel sides to the fore end, where it is $10\frac{1}{2}$ lines wide. The palate behind is nearly plane or slightly convex; at its fore part it presents a deep median groove, closed by the apposition of the maxillaries, and this groove is separated only by a narrow ridge from the alveoli. The sides of the maxillaries are slightly concave longitudinally, convex transversely. The intermaxillaries are broken away, leaving a wide, angular gutter between the remains of the maxillaries.”